Table 2-3 Potential Action-Specific ARARs, Criteria, Advisories and Guidance (Cont'd)

Authority/Action	Requirement	Status	Regulation Synopsis	Consideration in RI/FS
RCRA/Sediment	Federal - Resource Conservation and Recovery Act (RCRA) - Criteria for Classification of Solid Waste Disposal and Practices (40 CFR Part 257)	Potentially Relevant and Appropriate	Solid wastes containing PCBs greater than 10 ppm must not be incorporated into the soil (or mixed with surface soil) or applied to land or pasture crop production.	This criterion may have to be addressed for any debris, soil or sediments containing greater than 10 ppm of PCBs.
Sediment	State - Hazardous Sites Cleanup Act, 25 PA Code, Chap. 260-270	Potentially Relevant and Appropriate	This regulation determines the appropriate methodology which must be followed at hazardous waste sites, including monitoring requirements and cleanup criteria.	Development of cleanup criteria for the Cottman Avenue site may have to consider the requirements of this Act.
PA/Soil	State - Hazardous Sites Cleanup Act, 35 PA Statute, Chap. 6020	Potentially Relevant and Appropriate	Creates a state program independent of the Federal Superfund Program for the cleanup of hazardous waste sites.	Regulations for implementation of this program have not yet been developed.
PADER/Soil	State - (Guidance) Department of Environmental Resources Cleanup Standards for Contaminated Soils	To Be Considered	The DER's generic soil cleanup standards for organic and inorganic contaminants are based upon cancer and non-cancer direct contact risks and the contaminant's likelihood to impact groundwater.	The DER's soil cleanup standards may be used to develop remediation technologies and action levels for groundwater treatment at the Cottman Avenue Site.
CSL/Surface Water	State - Clean Streams Law, 25 PA Code, Chap. 93, 95 and 101	Potentially Relevant and Appropriate	The Clean Streams Law regulations provide for the protection of Pennsylvania waters. They set levels for discharge to surface waters such as lakes, ponds, rivers and streams.	Pennsylvania Clean Streams Law regulations may be used to develop appropriate remediation goals for any discharge to the Delaware River.

Table 2-3 Potential Action-Specific ARARs, Criteria, Advisories and Guidance (Cont'd)

Authority/Action	Requirement	Status	Regulation Synopsis	Consideration in RI/FS
CWA/Surface Water	Federal - CWA - Ambient Water Quality Criteria (AWQC) Protection of Freshwater Aquatic Life, Human Health, Fish Consumption	Potentially Relevant and Appropriate	AWQC are developed under the Clean Water Act (CWA) as guidelines from which the states develop water quality standards. CERCLA 121(d)(2) requires compliance with such guidelines when they are relevant and appropriate rather than an MCL, when protection of aquatic organisms is being considered at a site. Acute and chronic exposure levels are established for the protection of aquatic life. For the protection of human health, additional health-based criteria have been developed for 95 carcinogenic compounds; these criteria consider exposure to chemicals from drinking water and/or fish consumption..	AWQC may be used to characterize risk to freshwater aquatic life resulting from discharge of groundwater to the Delaware River.

Table 2-4 Human Health - Risk Based Contaminants of Concern

Contaminant	Medium / Exposure Pathway	Exposure Profile	Exposure Setting
Chromium VI and compounds	Particulate	Carcinogenic risk	Resident Adult (adult): Ambient Air Inhalation
Chromium VI and compounds	Particulate	Carcinogenic risk	Resident Adult (child): Ambient Air Inhalation
Polychlorinated biphenyls (PCBs)	Surface soil (courtyard)	Carcinogenic risk	Future Industrial Worker: Ingestion
Arsenic	Surface soil (outside courtyard)	Carcinogenic risk	Future Industrial Worker: Ingestion
Beryllium and compounds	Surface soil (outside courtyard)	Carcinogenic risk	Future Industrial Worker: Ingestion
Polychlorinated biphenyls (PCBs)	Surface soil (outside courtyard)	Carcinogenic risk	Future Industrial Worker: Ingestion
Polychlorinated biphenyls (PCBs)	Subsurface soil (outside courtyard)	Carcinogenic risk	Future Construction Worker: Ingestion
2,3,7,8-TCDD (dioxin)	Subsurface soil (outside courtyard)	Carcinogenic risk	Future Construction Worker: Ingestion
2,3,7,8-TCDD (dioxin)	Particulate	Carcinogenic risk	Future Construction Worker: Ambient Air Inhalation
Polychlorinated biphenyls (PCBs)	LNAPL	Carcinogenic risk	Future Construction Worker: Dermal Contact
2,3,7,8-TCDD (dioxin)	Rip-rap sediment	Carcinogenic risk	Recreational Boater (adult): Ingestion
2,3,7,8-TCDD (dioxin)	Rip-rap sediment	Carcinogenic risk	Recreational Boater (child): Ingestion
Polychlorinated biphenyls (PCBs)	Ingestion of fish	Carcinogenic risk	Recreational Boater (adult): Ingestion
Polychlorinated biphenyls (PCBs)	Ingestion of fish	Carcinogenic risk	Recreational Boater (child): Ingestion

Table 2-5 Contaminants of Concern Which Exceed ARARs and Federal Policies

POLICY BASED Contaminant	Medium	Maximum Detected Concentration (mg/kg)	Location	Policy Value (mg/kg)	Policy
Total PCBs	Surface Soil	140	TB2S	10	Federal Guidance[1]
Total PCBs	Sediment	19.6	MF107	1	Federal Guidance[1]

[1] PCB values taken from "Guidance on Remedial Actions for Superfund Sites with PCB Contamination", U.S. EPA, August 1990. The value for surface soil is for industrial areas, and the value for sediment is for aquatic environments.

Table 2-6 Human Health Risk - Based Interim Target Cleanup Levels (ITCLs)

Contaminant	Medium / Exposure Pathway	Exposure Setting	Exposure Point Concentration or RME conc.[1] (ppm)	Risk Estimate[2]	Interim Target Cleanup Levels (ITCLs)[3] (ppm)
Chromium VI and compounds	Particulate	Offsite Adult (adult): Ambient Air Inhalation	1.49E-07[4]	5.89E-07	2.53E-07[4]
Chromium VI and compounds	Particulate	Offsite Adult (child): Ambient Air Inhalation	1.49E-07[4]	4.12E-07	3.62E-07[4]
Polychlorinated biphenyls (PCBs)	Surface soil (courtyard)	Future Industrial Worker: Ingestion	92.4	4.14E-05	2.23
Arsenic	Surface soil (outside courtyard)	Future Industrial Worker: Ingestion	6.39	6.51E-07	9.82
Beryllium and compounds	Surface soil (outside courtyard)	Future Industrial Worker: Ingestion	1.10	2.75E-07	4.00
Polychlorinated biphenyls (PCBs)	Surface soil (outside courtyard)	Future Industrial Worker: Ingestion	1.51	6.79E-07	2.22
Polychlorinated biphenyls (PCBs)	Subsurface soil (outside courtyard)	Future Construction Worker: Ingestion	365	1.97E-05	18.5
2,3,7,8-TCDD (dioxin)	Subsurface soil (outside courtyard)	Future Construction Worker: Ingestion	4.35	4.56E-03	0.001
2,3,7,8-TCDD (dioxin)	Particulate	Future Construction Worker: Ambient Air Inhalation	2.17E-07[4]	4.56E-05	4.76E-09[4]
Polychlorinated biphenyls (PCBs)	NAPL	Future Construction Worker: Dermal Contact	1090	6.00E-03	0.182
2,3,7,8-TCDD (dioxin)	Rip-rap sediment	Recreational Boater (adult): Ingestion	5.91E-02	1.19E-05	0.005
2,3,7,8-TCDD (dioxin)	Rip-rap sediment	Recreational Boater (child): Ingestion	5.91E-02	2.78E-05	0.002
Polychlorinated biphenyls (PCBs)	Ingestion of fish	Recreational Boater (adult): Ingestion	1.27	2.62E-04	0.005
Polychlorinated biphenyls (PCBs)	Ingestion of fish	Recreational Boater (child): Ingestion	1.27	1.53E-04	0.008

[1] Exposure point concentrations are taken from the Human Health Risk Assessment. RME denotes the reasonable maximum exposure.
[2] Risk estimates are taken from the Human Health Risk Assessment.
[3] ITCLs are based on an ILCR of 1E-06.
[4] Concentration in mg/m^3

Table 2-7 Ecological Risk - Based Interim Target Cleanup Levels (ITCLs)

Contaminant	Medium	Organism	Interim Target Cleanup Level (ITCL) (ppm)
Total PCBs	LNAPL	Aquatic Species[1]	NA
Total PAHs	LNAPL	Aquatic Species[1]	NA
Total PCBs	Sediment	Aquatic Species	0.05
Total PAHs	Sediment	Aquatic Species[1]	32
4,4' DDD	Sediment	Terrestrial Species[2]	0.002

1 ITCL taken from the draft Aquatic Ecological Risk Assessment prepared by NOAA and is based on NOAA Effects Range-Median (Long and Morgan, 1990).

2 ITCL taken from the draft Terrestrial Ecological Risk Assessment prepared by EPA and is based on EEQs.

NA Not Applicable

Table 2-8 ARAR and Federal Policy - Based Interim Target Cleanup Levels (ITCLs)

POLICY BASED Contaminant	Medium	Maximum Detected Concentration (mg/kg)	Location	Policy Value (mg/kg)	Interim Target Cleanup Levels (ITCLs) (mg/kg)
Total PCBs	Surface Soil	140	TB2S	10[1]	10
Total PCBs	Sediment	19.6	MF107	1[1]	1

1 PCB valuesl taken from "Guidance on Remedial Actions for Superfund Sites with PCB Contamination," U.S. EPA, August 1990. The value for surface soil is for industrial areas, and the value for sediment is for aquatic environments.

Table 2-9 Background Level - Based Interim Target Cleanup Levels (ITCLs)

Contaminant	Background Soil Concentration-based[1] ITCLs[2] (mg/kg)
Arsenic	<0.1 - 73
Beryllium	<1 - 7
Chromium	1 - 1,000
4,4'-DDD	0.4 - 270[3]

1 Background soil concentration-based ITCLs are only applied when no other ITCL for a contaminant is available. Source: "Element Concentration in Soils and Other Surficial Materials of the Conterminous United States" 1984.

2 Interim Target Cleanup Levels (ITCLs).

3 Background concentrations based on the document "Sediment Contaminants of the Delaware River Estuary". Estuary Toxics Management Program Delaware River Basin Commission, March 1993.

Table 2-10 Summary of Interim Target Cleanup Levels (ITCLs) by Medium

MEDIUM: PARTICULATES Compound	Human Health Risk-Based ITCL (ppm)	Ecological Risk Based ITCL (ppm)	Policy-Based ITCL (ppm)	Background Soil Level-Based ITCL (ppm)	Target Cleanup Level (ppm)
Chromium VI and compounds	3.62E-07[1]	---	---	1 - 1,000	---

MEDIUM: SEDIMENTS Compound	Human Health Risk-Based ITCL (ppm)	Ecological Risk-Based ITCL (ppm)	Policy-Based ITCL (ppm)	Background Sediment Level-Based ITCL (ppm)	Target Cleanup Level (ppm)
Total PCBs	---	0.05	1	---	1
Total PAHs	---	32	---	---	32
4,4'-DDD	---	0.002	---	0.4 - 270	---
2,3,7,8-TCDD	0.002	1.3	---	---	0.002

MEDIUM: SURFACE SOIL (Courtyard) Compound	Human Health Risk-Based ITCL (ppm)	Ecological Risk Based ITCL (ppm)	Policy-Based ITCL (ppm)	Background Soil Level-Based ITCL (ppm)	Target Cleanup Level (ppm)
Total PCBs	---	---	10	---	10

MEDIUM: SURFACE SOIL (Outside Courtyard) Compound	Human Health Risk-Based ITCL (ppm)	Ecological Risk Based ITCL (ppm)	Policy-Based ITCL (ppm)	Background Soil Level-Based ITCL (ppm)	Target Cleanup Level (ppm)
Arsenic	9.82[1]	---	---	<0.1 - 73	---
Beryllium and compounds	4.00[1]	---	---	<1 - 7	---
Total PCBs	2.22[1]	---	10	---	---

1 The values provided exceed the exposure point concentrations taken from the Human Health Risk Assessment. Therefore, the determined ITCLs have been achieved.

Table 2-11 Evaluation of Target Cleanup Levels and Identification of Recommended Target Cleanup Levels

MEDIUM: SURFACE SOIL Compound	Target Cleanup Level (ppm)	Contract Required Quantitation Limits (CRQLs) (ppm)	Recommended Target Cleanup Level (ppm)	Source
Total PCBs	10	0.033	10	PB[1]

MEDIUM: SEDIMENTS Compound	Target Cleanup Level (ppm)	Contract Required Quantitation Limits (CRQLs) (ppm)	Recommended Target Cleanup Level (ppm)	Source
Total PCBs	1	0.033	1	PB
Total PAHs	32	0.330	32	ERB[2]
2,3,7,8-TCDD	0.002	---	0.002	HHRB[3]

[1] PB Policy Based
[2] ERB Ecological Based
[3] HHRB Human Health Risk Based

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Table 2-12 General Response Actions for Surface Soil

GENERAL RESPONSE ACTIONS (for all remedial action objectives)	REMEDIAL TECHNOLOGY TYPES (for general response actions)	PROCESS OPTIONS
NO ACTION/LIMITED ACTIONS: No Action Access Restrictions Monitoring	NO ACTION/LIMITED ACTION OPTIONS: Deed Restrictions Fencing Sampling	
CONTAINMENT ACTIONS: Containment	CONTAINMENT TECHNOLOGIES: Capping	Multimedia cap, permeable cap, single media cap
	Surface Controls	Grading, revegetation
	Vertical Barrier	Cofferdam, grout curtain, sheet piling, slurry wall
REMOVAL/TREATMENT/ DISPOSAL ACTIONS: Removal/Disposal Removal/Treatment/Disposal	REMOVAL TECHNOLOGIES: Excavation	Dredging, soil excavation
	TREATMENT TECHNOLOGIES: Biological Treatment	In-situ bioremediation, land treatment
	Chemical Treatment	Dechlorination
	Fixation/Stabilization	Asphalt-based (thermoplastic) microencapsulation, lime-based pozzolan, Portland cement pozzolan, sorption, vitrification
	Physical Treatment	Dewatering, evaporation, low temperature thermal stripping, soil washing, vacuum extraction
	Thermal Treatment	Circulating bed combustor, infrared incineration, pyrolysis, rotary kiln incineration
	DISPOSAL TECHNOLOGIES: Off-site Disposal	RCRA landfill, RCRA/TSCA landfill, Subtitle D Facility
	On-site Disposal	Backfilling, non-RCRA landfill, RCRA landfill

Table 2-13 General Response Actions for Sediments

GENERAL RESPONSE ACTIONS (for all remedial action objectives)	REMEDIAL TECHNOLOGY TYPES (for general response actions)	PROCESS OPTIONS
NO ACTION/LIMITED ACTIONS: No Action Access Restrictions Monitoring	NO ACTION/LIMITED ACTION OPTIONS: Deed Restrictions Fencing Sampling	
CONTAINMENT ACTIONS: Containment	CONTAINMENT TECHNOLOGIES: Capping	Multimedia cap, permeable cap, single media cap
	Surface Controls	Grading, revegetation
	Vertical Barrier	Cofferdams, grout curtain, sheet piling, slurry wall
REMOVAL/TREATMENT/ DISPOSAL ACTIONS: Removal/Containment Removal/Disposal Removal/Treatment/Disposal	REMOVAL TECHNOLOGIES: Excavation	Dredging, excavation
	TREATMENT TECHNOLOGIES: Biological Treatment	In-situ bioremediation, land treatment
	Chemical Treatment	Dechlorination
	Fixation/Stabilization	Asphalt-based (thermoplastic) microencapsulation, lime-based pozzolan, Portland cement pozzolan, sorption, vitrification
	Physical Treatment	Dewatering, evaporation, low temperature thermal stripping, soil washing, vacuum extraction
	Thermal Treatment	Circulating bed combustor, infrared incineration, pyrolysis, rotary kiln incineration
	DISPOSAL TECHNOLOGIES: Off-site Disposal	RCRA landfill, RCRA/TSCA landfill, Subtitle D Facility
	On-site Disposal	Backfilling, non-RCRA landfill, RCRA landfill

Table 2-14 General Response Actions for LNAPL

GENERAL RESPONSE ACTIONS (for all remedial action objectives)	REMEDIAL TECHNOLOGY TYPES (for general response actions)	PROCESS OPTIONS
NO ACTION/LIMITED ACTIONS: No Action Access Restrictions Monitoring	NO ACTION/LIMITED ACTION OPTIONS: Deed Restrictions Fencing Sampling	
CONTAINMENT ACTIONS: Containment	CONTAINMENT TECHNOLOGIES: Capping	Multimedia cap, permeable cap, single media cap
	Surface Controls	Dikes and berms, levees
	Vertical Barrier	Cofferdam, grout curtain, sheet piling, slurry wall
REMOVAL/TREATMENT/ DISPOSAL ACTIONS: Removal/Disposal Removal/Treatment/Disposal	REMOVAL TECHNOLOGIES: Subsurface Drains	Interceptor trenches
	Surface Drains	Collection drains, pumping, surface controls
	TREATMENT TECHNOLOGIES: Biological Treatment	Enzymatic degradation, aerobic lagoons, anaerobic lagoons, packed bed reactor, PACT activated sludge, rotating biological reactor
	Chemical Treatment	Ultraviolet photolysis
	Physical Treatment	Air stripping, carbon adsorption, centrifugation, dissolved air flotation, distillation, electrodialysis, filtration, flocculation, ion exchange, oil/water separation, reverse osmosis, sedimentation, steam stripping
	Thermal Treatment	Infrared incineration, pyrolysis, rotary kiln incineration
	DISPOSAL TECHNOLOGIES: Off-site Disposal	Deep well injection, POTW, RCRA TSD facility, RCRA/TSCA TSD facility
	On-site Disposal	Leachfield, recharge well, river

TABLE 3-1
Cost Summary for Remedial Alternative C-1: No Action

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	ITEM TOTALS	O&M COST (annual)	O&M TOTALS
1A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
	Sediments	20	set	$1,560			$31,200	
	Groundwater	20	set	$1,560			$31,200	
	Surface Water	24	set	$1,560			$37,400	
	NAPL	12	set	$1,560			$18,700	
	Labor & Other Costs						$183,400	

SUBTOTAL ALTERNATIVE 1A	$301,900
CONTINGENCY @ 15%	$45,285
TOTAL	$347,000

PRESENT WORTH (n=2 yrs, i=5%)	**$645,000**

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	ITEM TOTALS	O&M COST (annual)	O&M TOTALS
1B	LONG-TERM MONITORING (annually; yrs 3-30)							$75,600
	Sediments	5	set	$1,560			$7,800	
	Groundwater	5	set	$1,560			$7,800	
	Surface Water	6	set	$1,560			$9,400	
	NAPL	3	set	$1,560			$4,700	
	Labor & Other Costs						$45,900	

SUBTOTAL ALTERNATIVE 1B	$75,600
CONTINGENCY @ 15%	$11,340
TOTAL	$87,000

PRESENT WORTH (n=28 yrs, i=5%)	**$1,176,000**

TOTAL PRESENT WORTH	**$1,821,000**

TABLE 3-2
Cost Summary for Remedial Alternative C-2: Limited Action

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	G&M TOTAL
2A	SHORT-TERM MONITORING (quarterly - 2 years)							$30[illegible]
2B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
2C	DEED RESTRICTIONS	1	each	$10,000	$10,000	$10,000		
2D	ACCESS RESTRICTIONS*					$27,900*		$2,500
	Chain Link Fence	3500	lf	$14	$48,000			
	Miscellaneous				$4,800			
	Maintenance	1	ls	$2,500	$2,500		$2,500	
2E	WARNING SIGNS	10	each	$100	$1,000	$1,000		
2F	PUBLIC EDUCATION PROGRAM	1	ea.	$35,000	$35,000	$35,000	$4,000	$4,000
	SUBTOTAL ALTERNATIVE C-2					$73,900		
	ENGINEERING @ 10%					$7,390		
	CONTINGENCY @ 15%					$11,085		
	TOTAL					$92,000		
	PRESENT WORTH (n=30 yrs, i=5%)							**$2,028,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-3
Cost Summary for Remedial Alternative C-3: Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOTALS
3A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
3B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
3C	DEED RESTRICTIONS					$10,000		
3D	ACCESS RESTRICTIONS*					$27,900*		$2,500
3E	WARNING SIGNS					$1,000		
3F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
3G	REMOVAL AND DISPOSAL OF UST					$451,000		
	Removal of slab	30	cy	$150	$4,500			
	Excavation/Removal of tank	1	ea	$10,000	$10,000			
	Removal/ Disposal of tank contents	10000	gal	$16	$160,000			
	Backfill	180	cy	$10	$1,800			
	Compaction	180	cy	$3	$540			
	Steam-cleaning tank surfaces	4	hr	$375	$1,500			
	Collection/Disposal of cleaning matl	2500	gal	$16	$40,000			
	Disposal of Soil	290	tons	$475	$137,750			
	Transportation of Soil	290	tons	$125	$36,250			
	Miscellaneous				$58,850			
3H	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$47,575
	Sheet Pile Wall	56000	sf	$15	$840,000		$1,000	
	Trenching	3900	cy	$15	$58,500			
	Backfill	6700	cy	$10	$67,000			
	Compaction	6700	cy	$3	$20,100			
	Manholes	8	ea	$2,400	$19,200		$1,000	
	HDPE Collection Pipe	1800	lf	$40	$72,000		$1,000	
	Mobilization/Demobilization	1	ls	$60,000	$60,000			
	NAPL Collection and Disposal							
	NAPL Scavenger system	6	ea	$9,000	$54,000		$37,650	
	Drums	6	ea	$25	$150		$125	
	Drum heaters	6	ea	$200	$1,200		$1,200	
	Concrete containment area	6	ea	$1,000	$6,000			
	Disposal of NAPL	275	gal	$16			$4,400	
	Electrical	1	ls	$10,000	$10,000		$1,200	
	Miscellaneous				$500,000			

SUBTOTAL ALTERNATIVE C-3	$2,233,000
ENGINEERING @ 10%	$223,300
CONTINGENCY @ 15%	$334,950
TOTAL	$2,791,000
PRESENT WORTH (n=30 yrs, i=5%)	**$5,568,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

Table 3-4
Cost Summary for Remedial Alternative C-4: Permeable Cap/Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	[redacted]
4A	SHORT-TERM MONITORING (quarterly - 2 years)							[redacted]
4B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
4C	DEED RESTRICTIONS					$10,000		
4D	ACCESS RESTRICTIONS*					$27,900*		$2,500
4E	WARNING SIGNS					$1,000		
4F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
4G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
	Excavation	600	cy	$8	$4,800			
	Disposal	1000	tons	$475	$475,000			
	Transportation	1000	tons	$125	$125,000			
	Backfill	700	cy	$10	$7,000			
	Compaction	700	cy	$3	$2,100			
	Grading and Seeding	700	cy	$5	$3,500			
4H	REMOVAL AND DISPOSAL OF UST					$451,000		
4I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$47,575
4J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
	Clear and Grubbing	1	ls	$5,000	$5,000			
	Remove and Replace Riprap	1800	cy	$45	$81,000			
	Staging/Steam-cleaning area for riprap	1	ls	$50,000	$50,000			
	Steam-cleaning riprap	27300	sf	$15	$409,500			
	Mudflat and rip-rap sediments							
	Dedge sediments: clamshell	8900	cy	$25	$222,500			
	Backfill	9800	cy	$15	$147,000			
	Grading	9800	cy	$8	$78,400			
	Compaction	9800	cy	$3	$29,400			
	Cofferdam: dimensions 620 lf x 20 ft high	12400	sf	$15	$186,000			
	River sediments							
	Dredge sediments: clamshell	2850	cy	$25	$71,300			[redacted]
	Cofferdam: dimensions 875 lf x 40 ft high	35000	sf	$20	$700,000			
	Disposal of liquid waste from dredging				$1,000,000			
	Backfill	3135	cy	$15	$47,000			
	Handling	3135	cy	$25	$78,400			
	Miscellaneous							
	Mobilization/Demobilization	1	ls	$105,000	$105,000			
	Regulatory Compliance				$250,000			
	Miscellaneous				$500,000			
4K	PERMEABLE CAP					$330,000		$4,000
	Sand & Gravel Borrow	8700	cy	$12	$104,400			
	Grading	8700	cy	$8	$69,600			
	Compaction	8700	cy	$3	$26,100			
	Loam/Topsoil	4100	cy	$18	$73,800			
	Grading and Seeding	4100	cy	$5	$20,500			
	Monitoring Wells	5	ea	$1,200	$6,000			
	Miscellaneous				$30,000			
	Annual Maintenance						$4,000	

SUBTOTAL ALTERNATIVE C-4	$7,141,000
ENGINEERING @ 10%	$714,100
CONTINGENCY @ 15%	$1,071,150
TOTAL	$8,926,000
PRESENT WORTH (n=30 yrs, i=5%)	**$11,774,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

[redacted]

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TABLE 3-5
Cost Summary for Remedial Alternative C-5: Impermeable Cap
Flexible Membrane Liner Option

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOTALS
5A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
5B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
5C	DEED RESTRICTIONS					$10,000		
5D	ACCESS RESTRICTIONS*					$27,900*		$2,500
5E	WARNING SIGNS					$1,000		
5F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
5G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
5H	REMOVAL AND DISPOSAL OF UST					$451,000		
5I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$47,575
5J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
5K	IMPERMEABLE CAP (FML)					$1,513,000		$40,000
	Subgrade Preparation	48400	sy	$2	$96,800			
	Installation of FML	435600	sf	$0.75	$326,700			
	Sand & Gravel Borrow	34200	cy	$12	$410,400			
	Compaction	34200	cy	$3	$102,600			
	Loam/Topsoil	16100	cy	$18	$289,800			
	Grading and Seeding	16100	cy	$5	$80,500			
	Monitoring Wells	5	ea	$1,200	$6,000			
	Miscellaneous				$200,000			
	Annual Maintenance						$40,000	

SUBTOTAL ALTERNATIVE C-5	$8,324,000
ENGINEERING @ 10%	$832,000
CONTINGENCY @ 15%	$1,249,000
TOTAL	$10,405,000

PRESENT WORTH (n=30 yrs, i=5%)	**$13,889,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-6
Cost Summary for Remedial Alternative C-6: In Situ Solidification/Stabilization

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TC
6A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,[illegible]
6B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
6C	DEED RESTRICTIONS					$10,000		
6D	ACCESS RESTRICTIONS*					$27,900*		$2,500
6E	WARNING SIGNS					$1,000		
6F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
6G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
6H	REMOVAL AND DISPOSAL OF UST					$451,000		
6I	STABILIZING WALL					$900,000		
	Mobilization/Demobilization	1	ls	$60,000	$60,000			
	Sheet pile wall	56000	sf	$15	$840,000			
6J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
6K	IN SITU STABILIZATION					$10,434,000		
	Treatability Study	1	ls	$30,000	$30,000			
	Mobilization/Setup/Decon/Demob.	1	ls	$137,500	$137,500			
	Obstruction clearing by dry mixing	73000	cy	$19	$1,387,000			
	Solidification/Stabilization Process	73000	cy	$62	$4,526,000			
	Cement and Admixes	73000	cy	$40	$2,920,000			
	Excavate/remove obstructions	3700	cy	$8	$29,600			
	Steam-cleaning Obstructions	10000	sf	$15	$150,000			
	Relocation of Obstructions as Riprap	185	cy	$23	$4,300			
	Regulatory Compliance				$250,000			
	Miscellaneous				$1,000,000			
6L	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-6	$17,950,000
ENGINEERING @ 10%	$1,795,000
CONTINGENCY @ 15%	$2,692,500
TOTAL	$22,438,000
PRESENT WORTH (n=30 yrs, i=5%)	**$25,081,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-7
Cost Summary for Remedial Alternative C-7: In Situ Solidification/Stabilization with Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOTALS
7A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
7B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
7C	DEED RESTRICTIONS					$10,000		
7D	ACCESS RESTRICTIONS*					$27,900*		$2,500
7E	WARNING SIGNS					$1,000		
7F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
7G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
7H	REMOVAL AND DISPOSAL OF UST					$451,000		
7I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$43,475
	Sheet Pile Wall	56000	sf	$15	$840,000		$1,000	
	Trenching	3900	cy	$15	$58,500			
	Backfill	6700	cy	$10	$67,000			
	Compaction	6700	cy	$3	$20,100			
	Manholes	8	ea	$2,400	$19,200		$1,000	
	HDPE Collection Pipe	1800	lf	$40	$72,000		$1,000	
	Mobilization/Demobilization	1	ls	$60,000	$60,000			
	NAPL Collection and Disposal							
	NAPL Scavanger System	6	ea	$9,000	$54,000		$37,650	
	Drums	6	ea	$25	$150		$25	
	Drum heaters	6	ea	$200	$1,200		$1,200	
	Concrete containment area	6	ea	$1,000	$6,000			
	Disposal of NAPL	25	gal	$16			$400	
	Electrical	1	ls	$10,000	$10,000		$1,200	
	Miscellaneous				$500,000			
7J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
7K	IN SITU STABILIZATION					$10,434,000		
7L	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-7	$18,758,000
ENGINEERING @ 10%	$1,876,000
CONTINGENCY @ 15%	$2,814,000
TOTAL	$23,448,000
PRESENT WORTH (n=30 yrs, i=5%)	**$26,860,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-8
Cost Summary for Remedial Alternative C-8: Soil Washing/Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOT
8A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,[illegible]
8B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
8C	DEED RESTRICTIONS					$10,000		
8D	ACCESS RESTRICTIONS*					$27,900*		$2,500
8E	WARNING SIGNS					$1,000		
8F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
8G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
8H	REMOVAL AND DISPOSAL OF UST					$451,000		
8I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$43,475
8J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
8K	SOIL WASHING - TREATMENT					$5,643,000		
	20-Ton Crane	1	mo	$15,000	$15,000			
	Rigging Personnel	1	mo	$10,000	$10,000			
	Excavate soils	71000	cy	$8	$568,000			
	Temporary Staging	1	ls	$50,000	$50,000			
	Soil Conveyance	83000	cy	$1	$83,000			
	Soil Screening	83000	cy	$2	$166,000			
	Decon of Large Debris	50000	sf	$15	$750,000			
	Treatment Unit							
	Bench-scale Treatability	1	ls	$60,000	$60,000			
	Design Activities	1	ls	$10,000	$10,000			
	Plant Mob and Start-up	1	ls	$60,000	$60,000			
	Personnel Training	1	ls	$50,000	$50,000			
	Plant Lease (50 TPH)	34	wk	$34,000	$1,156,000			
	Temporary Tankage	38	wk	$2,500	$95,000			
	Plant Decon and Demob	1	ls	$80,000	$80,000			
	Plant Consumables	1	ls	$1,700,000	$1,700,000			
	Plant O&M	38	wk	$5,000	$190,000			
	Analytical				$300,000			
	Permitting				$300,000			
8L	SOIL WASHING - RESIDUAL TREATMENT					$7,317,400		
	Disposal of Waste Stream	300000	gal	$16	$4,800,000			
	Ex-Situ S/S of Contaminated Residual							
	Mob/Setup/Decon/Demob	1	ls	$35,000	$35,000			
	Loader	20000	cy	$3	$60,000			
	Mixing Equipment and Labor	20000	cy	$30	$600,000			
	Cement and Admixes	20000	cy	$40	$800,000			
	Forms	93600	sfca	$4	$374,400			
	Staging Area/Contaminated Fines	1	ls	$50,000	$50,000			
	Handling of Treated Material	7	mo	$10,000	$70,000			
	Haul/Dump Treated Material	26000	cy	$3	$78,000			
	Regulatory Compliance				$200,000			
	Miscellaneous				$250,000			
8M	REPLACEMENT OF TREATED SOILS					$1,071,000		
	Load, Haul and Dump Clean Soil	63000	cy	$6	$378,000			
	Grading	63000	cy	$8	$504,000			
	Compaction	63000	cy	$3	$189,000			
8N	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-8	$22,355,000
ENGINEERING @ 10%	$2,236,000
CONTINGENCY @ 15%	$3,353,000
TOTAL	$27,944,000
PRESENT WORTH (n=30 yrs, i=5%)	**$31,356,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

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TABLE 3-9
Cost Sumary for Remedial Alternative C-9: On site Incineration

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOTALS
9A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
9B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
9C	DEED RESTRICTIONS					$10,000		
9D	ACCESS RESTRICTIONS*					$27,900*		$2,500
9E	WARNING SIGNS					$1,000		
9F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
9G	STABILIZING WALL					$900,000		
9H	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
9I	REMOVAL AND DISPOSAL OF UST					$451,000		
9J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
9K	ON SITE INCINERATION					$33,003,300		
	Mobilization/Setup/Demobilization	1	ls	$10,000,000	$10,000,000			
	Excavate Soils	83,000	cy	$8	$664,000			
	Incineration	132,800	ton	$120	$15,936,000			
	Compaction	83,000	cy	$3	$249,000			
	Steamcleaning Obstructions	10,000	sf	$15	$150,000			
	Relocate Obstructions as Riprap	185	cy	$23	$4,300			
	Regulatory Compliance	1	ls	$3,000,000	$3,000,000			
	Miscellaneous	1	ls	$3,000,000	$3,000,000			
9L	REPLACEMENT OF TREATED SOILS					$1,411,000		
	Load, Haul and Dump Soil	83,000	cy	$6	$498,000			
	Grading	83,000	cy	$8	$664,000			
	Compaction	83,000	cy	$3	$249,000			
9M	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-9	$41,930,000
ENGINEERING @ 5%	$2,096,500
CONTINGENCY @ 15%	$6,289,500
TOTAL	$50,316,000
PRESENT WORTH (n=30 yrs, i=5%)	**$52,959,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-10
Cost Summary for Remedial Alternative C-10: On site Incineration and Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TO
10A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,
10B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
10C	DEED RESTRICTIONS					$10,000		
10D	ACCESS RESTRICTIONS*					$27,900*		$2,500
10E	WARNING SIGNS					$1,000		
10F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
10G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
10H	REMOVAL AND DISPOSAL OF UST					$451,000		
10I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$43,475
10J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
10K	ON SITE INCINERATION					$33,003,300		
10L	REPLACEMENT OF TREATED SOILS					$1,411,000		
10M	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-10	$42,738,000
ENGINEERING @ 5%	$2,136,900
CONTINGENCY @ 15%	$6,410,700
TOTAL	$51,286,000
PRESENT WORTH (n=30 yrs, i=5%)	**$54,698,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-11
Cost Summary for Remedial Alternative C-11: Off-site Disposal (TSDF)

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O&M TOTALS
11A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,900
11B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
11C	DEED RESTRICTIONS					$10,000		
11D	ACCESS RESTRICTIONS*					$27,900*		$2,500
11E	WARNING SIGNS					$1,000		
11F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
11G	STABILIZING WALL					$900,000		
11H	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
11I	REMOVAL AND DISPOSAL OF UST					$451,000		
11J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
11K	OFF-SITE DISPOSAL (TSDF)					$65,559,000		
	Excavation	71000	cy	$8	$568,000			
	Transportation	107900	tons	$125	$13,488,000			
	Disposal	107900	tons	$475	$51,253,000			
	Permitting of disposal				$250,000			
11L	REPLACEMENT OF SOILS					$1,491,000		
	Backfill	71000	cy	$10	$710,000			
	Grading	71000	cy	$8	$568,000			
	Compaction	71000	cy	$3	$213,000			
11M	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-11	$74,566,000
ENGINEERING @ 5%	$3,728,300
CONTINGENCY @ 10%	$7,456,600
TOTAL	$85,751,000

PRESENT WORTH (n=30 yrs, i=5%)	**$88,394,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

TABLE 3-12
Cost Summary for Remedial Alternative C-12: Off-site Disposal (TSDF) with Containment

ITEM No.	COMPONENT	QUANTITY	UNIT	UNIT COST	EXTENSION	CAPITAL COST	O&M COST (annual)	O& TO
12A	SHORT-TERM MONITORING (quarterly - 2 years)							$301,5
12B	LONG-TERM MONITORING (annually: yrs 3-30)							$75,600
12C	DEED RESTRICTIONS					$10,000		
12D	ACCESS RESTRICTIONS*					$27,900*		$2,500
12E	WARNING SIGNS					$1,000		
12F	PUBLIC EDUCATION PROGRAM					$35,000		$4,000
12G	EXCAVATION AND DISPOSAL OF COURTYARD SOIL					$617,000		
12H	REMOVAL AND DISPOSAL OF UST					$451,000		
12I	CONTAINMENT SYSTEM (SHEET PILE WALL AND LEACHATE COLLECTION)					$1,708,000		$43,475
12J	EXCAVATE SEDIMENT AND RESTORE MUDFLATS					$3,961,000		
12K	OFF-SITE DISPOSAL (TSDF)					$65,559,000		
	Excavation	71000	cy	$8	$568,000			
	Transportation	107900	cy	$125	$13,488,000			
	Disposal	107900	cy	$475	$51,253,000			
	Permitting of disposal				$250,000			
12L	REPLACEMENT OF SOILS					$1,491,000		
12M	IMPERMEABLE CAP (FML)					$1,513,000		$40,000

SUBTOTAL ALTERNATIVE C-12	$75,374,000
ENGINEERING @ 5%	$3,769,000
CONTINGENCY @ 10%	$7,537,000
TOTAL	$86,680,000
PRESENT WORTH (n=30 yrs, i=5%)	**$90,092,000**

* Fencing will be replaced in 15 years. Total shown is present worth of replacement cost.

Table 4-6 Comparative Analysis of Retained Alternatives

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Overall Protection of Human Health and the Environment	No additional protection of human health and environment. Risks would continue to exist at the site.	Would achieve overall protection of human health and environment.	Refer to C-5.	Refer to C-5.	Refer to C-5.
Compliance with ARARs/TBCs					
Chemical-Specific	*Surface Water* - Will not comply. The release of LNAPL from affected soil and sediment to the surface water would continue.	*Surface Water* - Will generally comply. Short-term non-compliance would be reduced by erosion and sedimentation controls, and working at low tide when possible.	*Surface Water* - Refer to C-5.	*Surface Water* - Refer to C-5.	*Surface Water* - Refer to C-5.
	Groundwater - Will not comply. No additional protection of groundwater resources would be provided.	*Groundwater* - Will generally comply. Impact to groundwater will be essentially removed by implementation of the impermeable cap.	*Groundwater* - Refer to C-5	*Groundwater* - Refer to C-5	*Groundwater* - Refer to C-5

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Compliance with ARARs/TBCs (Cont'd)					
Location-Specific	*Floodplains* - Will comply with floodplains ARAR. No remedial activities would take place within the 100 year floodplain.	*Floodplains* - Will not comply with floodplains ARAR. A variance would be required for remedial activities to occur within the 100 year floodplain. Other long-term and short-term compliance issues that may arise will mirror those addressed under the chemical-specific surface water ARAR.	*Floodplains* - Refer to C-5	*Floodplains* - Refer to C-5	*Floodplains* - Refer to C-5
	Property Lines - Will comply with the Property Lines ARAR. No remedial activities would take place within the 50 ft. buffer zone between a property line and remedial activity.	*Property Lines* - Will not comply with Property Lines ARAR. A variance would be required for remedial activities to occur within the 50 ft. buffer zone between a property line and remedial activity.	*Property Lines* - Refer to C-5	*Property Lines* - Refer to C-5	*Property Lines* - Refer to C-5

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Compliance with ARARs/TBCs (Cont'd)					
Location-Specific (Cont'd)	*Wetlands* - Will comply with Wetlands ARARs.	*Wetlands* - Will generally comply with Wetlands ARARs. Remedial activities would encroach upon wetlands and river thus requiring a variance. Other long-term and short-term compliance issues that may arise will mirror those addressed under chemical-specific surface water ARARs.	*Wetlands* - Refer to C-5	*Wetlands* - Refer to C-5	*Wetlands* - Refer to C-5
	Wildlife - Will not comply with Wildlife ARARs. This alternative does not contain any mitigative or preventive measures that would protect native biota from the effects of the contamination from the site.	*Wildlife* - Will generally comply with Wildlife ARARs. Long-term and short-term non-compliance issues that may arise will mirror those addressed under the chemical-specific surface waters ARARs.	*Wildlife* - Refer to C-5	*Wildlife* - Refer to C-5	*Wildlife* - Refer to C-5

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Compliance with ARARs/TBCs (cont'd)					
Action-Specific	*Excavation* - Will comply with Excavation ARARs.	*Excavation* - Will comply with Excavation ARARs with assistance of additional mitigative measures. Short-term non-compliance issues may arise while implementing remedial activities.	*Excavation* - Refer to C-5	*Excavation* - Refer to C-5	*Excavation* - Refer to C-5
	On-Site Treatment -Will comply with On-Site Treatment ARARs.	*On-Site Treatment* -Will comply with On-Site Treatment ARARs with assistance of additional mitigative measures. Short-term non-compliance issues may arise while implementing remedial activities.	*On-Site Treatment* - Refer to C-5	*On-Site Treatment* - Refer to C-5	*On-Site Treatment* - Refer to C-5

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Long-Term Effectiveness and Permanence					
Magnitude of residual risk	Long-term risks remain as under present condition.	Capping reduces risk related to exposure to waste material. Containment system controls LNAPL migration and migration of other contaminants off site.	Treatment reduces risks related to exposure to waste material and total volume of LNAPL capable of migration to collection system. Containment system controls residual LNAPL migration and migration of other contaminants off site.	Refer to C-7	Refer to C-7
Adequacy and Reliability of Controls	No controls over remaining contamination. No reliability.	Impermeable cap is a reliable technology which would require annual maintenance.	In-situ stabilization has been successfully performed at several NPL sites.	Soil washing has been successfully performed at NPL sites.	Off-site disposal is a reliable technology.
		Containment and leachate collection system are reliable technologies which would require annual maintenance.	Containment and leachate collection systems are reliable technologies which would require annual maintenance.	Containment and leachate collection systems are reliable technologies which would require annual maintenance.	Containment and leachate collection systems are reliable technologies which would require annual maintenance.

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Reduction of Toxicity, Mobility, or Volume Through Treatment					
Degree of expected reduction in toxicity, mobility or volume through treatment	No treatment will occur; therefore, no reduction of toxicity, mobility, or volume will occur.	No treatment will occur. Mobility will be reduced by the containment system. Some volume reduction will occur with the LNAPL collection system, removal of the UST and the courtyard soil.	Toxicity and mobility will be reduced by stabilization. Mobility of residual contamination will be further reduced by the containment system.	Toxicity, mobility and volume will be reduced by this alternative. The mobility of residual contamination will be further reduced by the containment system.	No treatment will occur on site. The mobility of the contaminated material will be reduced by off-site disposal. Mobility of residual contamination will be further reduced by the containment system.
Degree to which treatment is irreversible	No treatment	No treatment	Irreversible	Irreversible	No treatment will occur on site. Dependent upon type of final treatment and/or disposal
Type and quantity of treatment residual	No treatment	No treatment	Very large quantity of concrete-like monolithic residual.	Moderate quantity concrete-like monolithic residual.	No treatment will occur on site. Dependent upon type of final treatment and/or disposal.
Statutory preference for treatment	Does not satisfy.	Does not satisfy.	Would satisfy preference.	Would satisfy preference.	Would not satisfy preference, treatment or disposal would occur off site.

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Short-Term Effectiveness					
Protection of community during remedial action	High short-term effectiveness	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures and air monitoring would be implemented.	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures and air monitoring would be implemented.	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures and air monitoring would be implemented.	Low short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures and air monitoring would be implemented.
Protection of workers during remedial actions	High short-term effectiveness	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures, air monitoring and personal protection equipment would be implemented.	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures, air monitoring and personal protection equipment would be implemented.	Moderate short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures, air monitoring and personal protection equipment would be implemented.	Low short-term effectiveness. Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures, air monitoring and personal protection equipment would be implemented.
Environmental Impact	High short-term effectiveness. Allows continued release of contaminants into the environment. No adverse environmental impacts during implementation.	Moderate short-term effectiveness. Excavation of contaminated mudflat and river sediment would have minor short-term impact on river and wetlands.	Moderate short-term effectiveness. Excavation of contaminated mudflat and river sediment would have minor short-term impact on river and wetlands.	Moderate short-term effectiveness. Excavation of contaminated mudflat and river sediment would have minor short-term impact on river and wetlands.	Low short-term effectiveness. Excavation of contaminated mudflat and river sediment would have minor short-term impact on river and wetlands.

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Implementability					
Protection of community during remedial action	High short-term effectiveness	Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures and air monitoring would be implemented.	Refer to C-5	Refer to C-5	Refer to C-5
Protection of workers during remedial actions	High short-term effectiveness	Adverse short-term impacts may occur from the release of VOCs and fugitive dust during excavation. Dust control measures, air monitoring and personal protection equipment would be implemented	Refer to C-5	Refer to C-5	Refer to C-5
Environmental Impact	Allows continued release of contaminants into the environment. No adverse environmental impacts during implementation.	Excavation of contaminated mudflat and river sediment would have minor short-term impact on river and wetlands.	Refer to C-5	Refer to C-5	Refer to C-5

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Implementability (Cont'd)					
Technical Feasibility					
Ability to construct and operate technologies	Easy.	Easy.	Moderate to difficult.	Difficult.	Moderate.
Reliability of technology	None.	Moderate.	Moderate.	Moderate.	Moderate.
Ease of undertaking additional remedial action, if necessary	Easy.	Easy.	Difficult.	Easy.	Easy.
Monitoring consideration	Required.	Required.	Required	Required	Required
Administrative Feasibility					
Coordination with other agencies	Will require coordination between EPA and PADER.	Will require coordination among EPA, PADER, and the Army Corps of Engineers.	Will require coordination among EPA, PADER, and the Army Corps of Engineers.	Will require coordination among EPA, PADER, and the Army Corps of Engineers.	Will require coordination among EPA, PADER, and the Army Corps of Engineers.
Availability of Services and Materials	Readily available.	Readily available.	Readily available.	Several vendors are available.	Several disposal facilities available.

Table 4-6 Comparative Analysis of Retained Alternatives (Cont'd)

Criteria	C-1 No Action	C-5 Impermeable Cap/ Containment System	C-7 In-Situ Stabilization/ Containment	C-8 Soil Washing/ Containment	C-12 Off-Site Disposal/ Containment
Cost					
Capital Cost		$10,405,000	$23,448,000	$27,944,000	$86,680,000
Operation and Maintenance[1]	$87,000	$195,000	$190,000	$190,000	$182,000
Present Worth	$1,821,000	$13,889,000	$26,860,000	$31,356,000	$90,092,000

[1] Operation and Maintenance values listed represent annual costs for years 3 through 30. Costs for years 1 and 2 would be greater by $260,000, due to quarterly rather than annual monitoring.

Appendix A

MEMORANDUM

HMM ASSOCIATES, INC.
196 Baker Avenue
Concord, MA 01742

DATE: April 7, 1994
TO: Cottman Avenue Technical Committee
FROM: Peter Swinick, Joseph Higgins
SUBJECT: Evaluation of Recoverable Oil at Metal Bank/Cottman Avenue Site Project Number 6698-100

The purpose of this memo is to present the results of our evaluation of the presence of recoverable oil in the subsurface at the Cottman Avenue site. For this evaluation, we reviewed available site background information, field measurements, historical volume estimations of recovered oil, and groundwater extraction/treatment history.

Background

The Metal Bank/Cottman Avenue national Priorities List Site is located at the corner of Cottman Avenue and Milnor Street in an industrial area of northeastern Philadelphia, Pennsylvania. The site is bordered by Cottman Avenue on the west, Milnor Street on the north, Hancock Paper Company and Morris Iron and Steel Company on the east, and the Delaware River on the south. To the west of Cottman Avenue is St. Vincent's School. A City of Philadelphia stormwater outfall is located at the southern end of Cottman Avenue. This outfall discharges onto a mud flat area which is immediately adjacent to the western boundary of the site.

The site property consists of two areas: the former scrap metal recovery area, encompassing approximately six acres on the southern portion of the property, and the building area, located on the northern portion of the property. The building area near Cottman Avenue includes six buildings. Site access is controlled by locked buildings and a six-foot-high fence along all sites of the southern portion of the site, except for the portion bordering the river.

Historical information on past site usage indicates that, from 1968 to 1972, U.C.O.-M.B.A., Inc., formerly known as Metal Bank of America, Inc. ("Metal Bank"), operated a metal reclaiming facility on the site. An underground storage tank at the southern end of the site was associated with this operation and is believed to have been the source of releases of oil into the subsurface environment at the site.

The topography of the site has been altered by filling; fill materials ranging up to eighteen feet in thickness covers the site. Based upon subsurface investigations to date, the surficial fill consists of one to three feet of silty sand and gravel which was deposited as capping/grading material over the southern portion of the site. The intermediate fill consists of five to fifteen feet of imported fill

reportedly deposited between 1950 and 1979. Explorations to date reveal that this fill contains sand and gravel with varying amounts of trash, debris and silt. Black staining and petroleum odors have been noted during subsurface explorations into this fill unit.

Delaware River alluvial deposits are believed to underlie the fill at the site. Mud flat sediments adjacent to the site consists of fine-grained silty sand with varying amounts of clay and vegetative material/debris.

The site came to the attention of the U.S. Coast Guard (USCG) in 1972, when oil was observed to be seeping from the southwestern bank of the site into the Delaware River. Laboratory analysis of the oil by the Environmental Protection Agency (EPA) did not detect polychlorinated biphenyl compounds (PCBs) at the time.[1] The USCG requires the site owner to contain the slick and improve scrap metal management practices. In 1977, improved technology for laboratory analysis revealed PCBs in the original 1972 oil samples and in soil samples collected in 1977.[1] The detection of PCBs in 1977 prompted studies by several consultants for the regulatory agencies and site owners.

Past action at the site has included pumping and treatment of groundwater to remove oil and PCBs. These recovery operations were reportedly terminated in accordance with a judicial order on June 12, 1989. Since that time, the recovery wells have been permanently closed, the oil recovery system dismantled and removed, and the area covered with fill. Approximately 80 percent of the site has been regraded and seeded. A concrete pad area and the southwestern portion of the site adjacent to the river and mud flat were reportedly regraded and seeded in early 1990.

Investigation and Remediation History

In 1977, three monitoring wells were installed at the site to evaluate the presence of oil in the subsurface. Because oil was detected in the three wells, Roy F. Weston (Weston) installed nineteen additional monitoring wells in 1978 to assist in determining the nature and extent of the oil.

Based on observations and measurements from these wells, Weston estimated that there were 21,000 gallons of oil in the subsurface. Weston later revised this figure to 16,000 gallons of oil in 1980. Weston assumed that 75% (or 12,000 gallons) of this volume of oil would be recoverable. A groundwater/oil recovery and treatment system consisting of 3 recovery wells, an oil/water separator, carbon treatment units, and a waste oil storage tank operated from 1981 to 1989. Groundwater/oil recovery consisted of a groundwater depression pump discharging to the treatment system and an oil pump discharging directly to an above ground holding tank. Initially the system flow rate was approximately 10,000 gallons per day (approximately 7 gallons per

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1 BCM, March 1991. *"Work Plan for Remedial Investigation/Feasibility Study".*

minute), year round. The system was modified in September 1982 to recharge the treated effluent to the groundwater in an attempt to flush oil from the subsurface soils. Beginning in the winter of 1984-85, the system was shut down during winter months due to treatment difficulties associated with colder temperatures.

By November 1982, the system had collected 3,125 gallons of oil. Over four year later, a total of 4,144 gallons of oil (or an additional 1,019 gallons) were reportedly collected. These measurements indicate that the recovery of oil was continually decreasing over time. In a final evaluation report of Remedial Investigation/Feasibility Study (RI/FS) documents by NUS Corp. for the EPA dated August 1987, NUS noted that the system was collecting less than one gallon of oil per day of operation and there were no longer releases of oil to the river from the site. As described in a 1989 letter form the EPA to Metal Bank's legal counsel, recovery well #1 oil thickness measurements before and after winter shutdown further reflects decreasing amounts of recoverable oil over time. Apparently, oil was not detected in recovery wells #2 and #3 shortly after start-up of the recovery system. A table of this data is presented below.

Oil Thickness Associated with Winter Shut-downs

Winter shut-down*			Spring start-up		
Date	**Recovery Well #**	**Oil Thickness**	**Date**	**Recovery Well #**	**Oil Thickness**
12/10/84	1	1/4"	3/13/85	1	3"
12/13/85	1	1/2"	4/10/86	1	3 1/4"
12/19/86	1	1/8"	3/16/87	1	1/4"
12/18/87	1	N.D.	3/16/88	1	3/4"

Although the oil recovery system operated until June, 1989, the volume of oil collected from the subsurface after the last reported amount of 4,144 gallons in 1986 was not found in the site documents reviewed.

Recoverable Product Evaluation

A 1989 report from Tetra Tech, Inc., another consultant to the EPA, modeled the radius of influence for the groundwater/oil recovery system at the site and concluded that the location of the recovery wells, given the estimated radii of influence, did not reach all areas potentially containing subsurface oil. This model, however, assumed a "homogenous, flat lying aquifer,

* System continued to operate through winter season of 1988-89.

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which varies considerably from the actual site conditions". The potential for preferential flow paths with higher permeabilities at this site due to the heterogeneous nature of the fill material may allow recovery wells to have a greater influence on the oil layer. Furthermore, the recovery wells were located in areas where oil was detected, at least during initial extraction/treatment, and these wells actually captured at least 4,144 gallons.

Although groundwater seeps with an oil sheen have recently been observed emanating from the southwest bank of the site, this does not necessarily indicate that recoverable oil exists in the subsurface. In May and June of 1992, HMM personnel detected oil in three monitoring wells using an electronic interface probe. Apparent oil thickness ranged from less than 0.01 feet to 0.29 feet. However, HMM personnel were not able to collect an oil sample from any of these wells because only sheens or droplets of oil were observed. When the wells were purged for groundwater sampling, only a thin sheen was noted in the purge water from these wells. Small accumulations of oil may continue to be detected in these and other wells due to fluctuations in the groundwater.

The oil thickness measured in a monitoring well (called the apparent thickness) is usually greater than the actual, or true, thickness, of oil within the subsurface. The oil within the subsurface will be perched on top of the capillary fringe. The capillary fringe is the height above the saturated zone (above the water table) in which water is held by tension within the pores of the soil. During the installation of monitoring wells (or other subsurface investigations), the capillary fringe is destroyed, and oil will migrate down into the well and rest on top of the water in the well. The oil then depresses the water table in the well due to its density, resulting in a greater apparent thickness of oil measured in the well than actually exists in the formation. At the Cottman Avenue site, it is expected that the oil thickness in the wells would be greater than the true thickness in the formation.

The Weston subsurface oil estimates did not take into account the different apparent and true product thicknesses. Based on a capillary fringe height of 2 to 6 inches and a specific gravity of the oil of 0.797 (Weston, 1980), measured product thickness can be corrected for water level depression. When product thicknesses are corrected, the calculated amount of oil in the subsurface decreases from 16,000 gallons to 12,700 gallons.

The height of water table fluctuation due to seasonal or tidal variations will also have an effect on measured oil thickness and amount of recoverable oil. As the groundwater table declines, the oil layer above it will also move downward, and locally may flow preferentially into the well (i.e., path of least resistance) causing an increase in measured or apparent oil thickness. Conversely, as the water table rises, a thinner oil layer will be observed.

Constant water table fluctuations will cause oil to become trapped within the soil pores below the oil/water interface. The continued fluctuation of the groundwater level will also cause a staining or smearing of the oil onto "clean" soil, rendering oil recoverability difficult. The greater the height and frequency of the fluctuation, the greater the subsurface thickness (and therefore

volume) over which the oil will be smeared. Concentrations of total petroleum hydrocarbons from soil borings drilled in the area where oil has been observed and tidal data at the site indicate that smearing of oil has occurred.

The type of soil in the formation will impact the amount of released product that is recoverable in the subsurface. Immobile product in the water table capillary zone, in the soil pore space and trapped by soil adsorptive effects are considered residual, unrecoverable product. The percentage of product that will drain and can be recovered under the influence of gravity, termed the specific yield, is dependent upon the flow characteristics of oil and the hydrogeologic characteristics of the formation. Typical values for specific yield range from 5% to 30%[2] which is much lower than Weston's specific yield estimate of 75%. Using a conservative specific yield of 30% and the correct spill volume of 12,700 gallons, the amount of recoverable product would be approximately 3,800 gallons.

Another method of estimating the amount of recoverable product is to estimate the amount of product the subsurface can retain in the soil matrix. The typical residual saturation value from literature[2] given the site soil type is 0.15 to 0.20 gallons of oil retention capacity per cubic foot of soil. Based on an areal extent of oil of 44,120 ft^2 as shown on the 1980 Weston report, and assuming the thickness of the product-saturated soil to be the thickness of the product layer (0.77 ft.) plus a 0.5 foot smear zone (which is conservative based on soil boring data collected at the site), an estimated 8,400 to 11,000 gallons of product could be retained in the on-site soils. Again using the corrected spill volume of 12,700 gallons, an estimated 1,500 to 4,300 gallons of product would be recoverable.

According to periodic operational reports, the volume of oil collected in 5-1/2 (out of 8) years of operation was approximately 4,200 gallons, which is consistent with the amount of recoverable product predicted by the two methods presented above. The decline in oil recovery efficiency after 5-1/2 years of operation and the sporadic observation of oil in the wells and sheens on the seeps to the Delaware River further indicate that the majority of recoverable oil was collected by the groundwater extraction/treatment system.

Conclusion

Based on the information reviewed for the Cottman Avenue site, although oil has recently been observed in the on-site monitoring wells, it is our opinion that much, if not all, of the subsurface residual oil is not recoverable. The former groundwater/oil extraction and treatment system operated from 1981 to 1989 and recovered an excess of 4,000 gallons of oil. Estimates by others indicate that 16,000 to 21,000 gallons of oil were present in the subsurface. However, HMM's review of those calculations indicate that corrections were not applied to the apparent, or

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2 Testa, S.M. and M.T. Paczkowski, 1989. Volume determination and recoverability of free hydrocarbon. Groundwater Monitoring Review. Winter, pp. 120-128.

measured product thickness in the monitoring wells and the calculated volume of oil should be approximately 12,700 gallons. HMM's research and experience indicates that up to 4,300 gallons of oil in the subsurface is recoverable at the Cottman Avenue site. Our research also indicated that the soil in the zone of separate phase product will potentially hold between 8,400 and 11,00 gallons of residual unrecoverable oil.

The presence of residual unrecoverable oil in the subsurface is reinforced by recent measurements in monitoring wells which indicate that only a sheen of oil is present, and by field observations of sheens and droplets on groundwater samples collected from several monitoring wells. It is our experience that recovery of oil from the groundwater table is generally not feasible when the apparent thickness of oil is less than approximately one inch.

Appendix B

Project: Cottman Avenue
Project #: 6698-402
Date: 5/18/94
Subject: Oil Saturation in Soils (TPH)

Objective: Oil Saturation Value (OSV) in mg/Kg Total Petroleum Hydrocarbons (TPH)

Given: **Density of Soil (D) = 150#/ft3**
Specific Gravity of PCB laddened Minerail Oils (s) = 1.1
Residual Saturation Value of Oil Retention Capacity (ORC) = 0.20 gallons/ft3
Conversion Factor Kv = 3785 ml/gallom
Conversion Factor Kw = 454 grams/pounds

Solution: **Grams of Oil in Soil (Go) = ORC * Kv * s**
Go = 0.20 gallon/ft3 * 3785 ml/gallon * 1.1 g/ml
Go = 833 grams of oil/ft3

Grams of Soil per ft3 (Gs) = D * Kw
Gs = 150#/ft3 * 454 grams/#
Gs = 68,100 grams of Soil

OSV = (Go *1000mg/g) / (Gs * 1Kg/1000 g)
OSV = 833 *1000/68100 * 0.001
OSV = 12,232 mg/Kg (TPH)

If ORC = 0.15 gallons/ft3 of Soil
Then OSV = (12232/0.20)*0.15
OSV = 9,174 mg/Kg (TPH)